Claims

What is claimed is:

1. A method for reconstructing the surface of an object, said method comprising the steps of:

obtaining multiple sets of three-dimensional scan data of said object;

finding a seed triangle in said scan data to form a triangulated mesh;

pivoting a ball around an edge of said triangulated mesh until a new point in said scan data is hit by said ball, wherein said edge and said new point define a new triangle;

adding said new triangle to said triangulated mesh;

selecting a new edge of said triangulated mesh and repeating said pivoting and adding steps until said surface is reconstructed.

2. The method of claim 1, wherein step of finding a seed triangle further comprises the step of finding a triangle such that a ball of radius ρ touching each point in said seed triangle contains no other data point in said scan data.

3. The method of claim 1, wherein said step of finding a seed triangle further comprises the steps of:

i. picking any point σ not yet used by said mesh;

ii. considering all pairs of points σ_a, σ_b in a neighborhood of said point in order of distance from σ;

iii. building potential seed triangles σ, σ_a, σ_b;

iv. checking that the triangle normal points outward;

v. testing that a ρ-ball with center in the outward halfspace touches all three vertices and contains no other data point; and

vi. stopping when a valid seed triangle has been found.

4. The method of claim 1, wherein said reconstructed surface is a manifold subset of an alpha-shape of the point set.

5. The method of claim 1, wherein said three-dimensional scan data is acquired using a laser range scanner.

6. The method of claim 1, wherein said three-dimensional scan data is acquired using a stereographic system.

7. The method of claim 1, further comprising the step of registering said scan data to align said multiple sets of scan data into a single coordinate system.

8. The method of claim 1, wherein a radius, ρ, of said ball is selected such that said three-dimensional scan data of said object is dense enough that said ball of radius ρ cannot pass through a surface without touching points in said scan data.

9. The method of claim 1, wherein the intersection of any ball of radius ρ with said object must be a topological disk, such that the radius of curvature of said object is larger than ρ, and that the ball of radius ρ can also pass through cavities and other concave features of said object without multiple contacts with the surface of said object.

10. The method of claim 1, wherein said data points are stored in a list, and said list is organized using a bucket-sort so that points lying in the same voxel form a contiguous sublist, wherein each voxel stores a pointer to the beginning of its sublist of

points.

11. The method of claim 10, wherein an active-edge front of said mesh is represented as a collection of linked lists of edges, and is initially composed of a single loop containing the three edges defined by said seed triangle.

12. The method of claim 11, wherein each edge of the front is represented by its two endpoints, the opposite vertex, the center of the ball that touches all three points, and links to the previous and next edge along in the same loop of the front.

13. The method of claim 1, wherein said step of pivoting a ball further comprises the step of labeling said edge as a boundary edge if no other point is hit by the ball.

14. A method for reconstructing the surface of an object, said method comprising the steps of:

i. obtaining multiple sets of three-dimensional scan data of said object;

ii. placing a ball of a given radius in contact with three initial points in said scan data, said three initial points forming a one-triangle mesh;

iii. keeping said ball in contact with two points on the active-edge front of said mesh and pivoting said ball until it touches another point in said scan data, said two contact points forming an edge;

iv. forming a new triangle with said triplet of points contacted by said ball;

v. adding said new triangle to said mesh;

vi. selecting a new edge in said mesh and repeating steps iii. through v.

15. The method of claim 14, wherein step of finding three initial points comprises the step of finding a triangle such that a ball of radius ρ touching each point in said seed triangle contains no other data point in said scan data.

16. The method of claim 14, wherein said step of finding three initial points further comprises the steps of:

i. picking any point σ not yet used by said mesh;
ii. considering all pairs of points σ_a, σ_b in a neighborhood of said point in order of distance from σ;
iii. building potential seed triangles σ, σ_a, σ_b;
iv. checking that the triangle normal points outward;
v. testing that a ρ-ball with center in the outward halfspace touches all three vertices and contains no other data point; and
vi. stopping when a valid seed triangle has been found.

17. The method of claim 14, wherein said reconstructed surface is a manifold subset of an alpha-shape of the point set.

18. The method of claim 14, wherein said three-dimensional scan data is acquired using a laser range scanner.

19. The method of claim 14, wherein said three-dimensional scan data is acquired using a stereographic system.

20. The method of claim 14, further comprising the step of registering said scan data to align said multiple sets of scan data into a single coordinate system.

21. The method of claim 14, wherein a radius, ρ, of said ball is selected such that said three-dimensional scan data of said object is dense enough that said ball of radius ρ cannot pass through a surface without touching points in said scan data.

22. The method of claim 14, wherein the intersection of any ball of radius ρ with said object must be a topological disk, such that the radius of curvature of said object is larger than ρ, and that the ball of radius ρ can also pass through cavities and other concave features of said object without multiple contacts with the surface of said object.

23. The method of claim 14, wherein said data points are stored in a list, and said list is organized using a bucket-sort so that points lying in the same voxel form a contiguous sublist, wherein each voxel stores a pointer to the beginning of its sublist of points.

24. The method of claim 23, wherein an active-edge front of said mesh is represented as a collection of linked lists of edges, and is initially composed of a single loop containing the three edges defined by said seed triangle.

25. The method of claim 24, wherein each edge of the front is represented by its two endpoints, the opposite vertex, the center of the ball that touches all three points, and links to the previous and next edge along in the same loop of the front.

26. The method of claim 14, wherein said step of pivoting a ball further

comprises the step of labeling said edge as a boundary edge if no other point is hit by the ball.

27. A system for reconstructing the surface of an object, comprising:

a memory that stores computer-readable code; and

a processor operatively coupled to said memory, said processor configured to implement said computer-readable code, said computer-readable code configured to:

obtain multiple sets of three-dimensional scan data of said object;

find a seed triangle in said scan data to form a triangulated mesh;

pivot a ball around an edge of said triangulated mesh until a new point in said scan data is hit by said ball, wherein said edge and said new point define a new triangle;

add said new triangle to said triangulated mesh;

select a new edge of said triangulated mesh and repeating said pivoting and adding steps until said surface is reconstructed.

28. A system for reconstructing the surface of an object, comprising:

a memory that stores computer-readable code; and

a processor operatively coupled to said memory, said processor configured to implement said computer-readable code, said computer-readable code configured to:

i. obtain multiple sets of three-dimensional scan data of said object;

ii. place a ball of a given radius in contact with three initial points in said scan data, said three initial points forming a mesh;

iii. keep said ball in contact with two points on the active-edge front of said mesh and pivoting said ball until it touches another point in said scan data, said two contact points forming an edge;

iv. form a new triangle with triplets of points contacted by said ball;

v. add said new triangle to said mesh;

vi. select a new edge in said mesh and repeat steps iii. through v.

29. An article of manufacture for reconstructing the surface of an object, comprising:

a computer readable medium having computer readable code means embodied thereon, said computer readable program code means comprising:

a step to obtain multiple sets of three-dimensional scan data of said object;

a step to find a seed triangle in said scan data to form a triangulated mesh;

a step to pivot a ball around an edge of said triangulated mesh until a new point in said scan data is hit by said ball, wherein said edge and said new point define a new triangle;

a step to add said new triangle to said triangulated mesh;

a step to select a new edge of said triangulated mesh and repeating said pivoting and adding steps until said surface is reconstructed.

30. An article of manufacture for reconstructing the surface of an object, comprising:

a computer readable medium having computer readable code means embodied thereon, said computer readable program code means comprising steps to:

i. obtain multiple sets of three-dimensional scan data of said object;

ii. place a ball of a given radius in contact with three initial points in said scan data, said three initial points forming a mesh;

iii. keep said ball in contact with two points on the active-edge front of said mesh and pivoting said ball until it touches another point in said scan data, said two contact points forming an edge;

iv. form a new triangle with triplets of points contacted by said ball;

v. add said new triangle to said mesh;

vi. select a new edge in said mesh and repeat steps iii. through v.